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LAND SURVEYING.

BY THE EDITOR.

The object of this article is to point out some of the practical difficulties encountered in ordinary land surveying.

The instruments used, in this country, in land surveying are, the Surveyor's Compass, the Surveyor's Transit, and the Solar Compass; the merit of each of which depends upon the kind of work to be done and the locality of the survey. When it is required to do the work in the least practicable time and with but ordinary accuracy, and especially in a timbered country, the surveyor's compass, on a tripod with ball and socket mounting, is perhaps the best. But in open country, and if a considerable degree of accuracy is required, the surveyor's transit is by far the best.

The Solar Compass is chiefly used, in this country, for surveying base lines, meridians, and the exterior township lines in the government surveys, for which purpose the Commissioner of the general land office, in his instructions to Surveyors General of public lands, directs it to be used.

The chief practical difficulty in making surveys with a good instrument of either of the first two kinds mentioned above is the local, and the daily variation of the magnetic needle. The local variation may be temporary or permanent. Against the first of these the vigilance of the surveyor may be sufficient to guard, and of the second he *should* be notified by the record of the original survey as made with the solar compass. But as such record is not always to be found, and not always reliable *when* found, the surveyor should determine the variation at as many points as practicable by astronomical observation, and supplement his knowledge of any local variation in the vicinity where his work may chiefly lie by transit lines between the points of observation.

The daily variation of the needle, although its range is less extended, is, in general, more embarrassing to the surveyor than the local variation, for, although it seldom exceeds a fourth of a degree, yet as it is irregular he has no means of knowing its exact value at any time unless he can compare his bearing with some known course, which is not in general practicable in ordinary surveying.

Besides the variations of the magnetic needle above alluded to, and besides the secular variation, which is different for different places, there is an occasional variation frommeteoric disturbances, or "magnetic storms," from which I have noticed a temporary deflection of the needle through more than a degree of are.

Considering all these sources of error, to say nothing of the errors of observation and measurment, it will readily be seen that the results obtained in ordinary land surveying are but rough approximations towards accuracy.

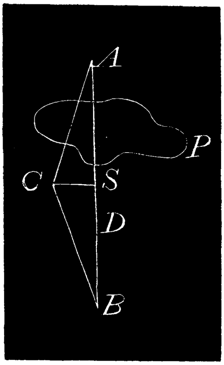
Theoretically the Solar Compass obviates the errors above alluded to, and to which a reliance on the magnetic needle gives rise. Practically however there are inconveniencies and difficulties attending the use of the solar compass, so that, in ordinary land surveying, and after permanent local variations have been determined, it is doubtful whether the same amount of work can be done, in a given time, with the solar compass with more accuracy than with the ordinary compass or transit.

The principal objection to the use of the solar compass in an open country results from the circumstance that it cannot be used with ordinary accuracy when the sun is within fifteen degrees of the meridian, nor again when the sun is near the horizon, which, in connection with the fact that the sun is frequently obscured by clouds when a sight by the compass is desired, so far curtails the time at the disposal of the surveyor that the average length of a day's work with the solar compass falls far short of a day's work with the ordinary compass or transit. And, in addition to the loss of time from the causes above enumerated, the instrument must be *accurately* leveled at every station, otherwise the course indicated will be in error; the use of a ball and socket mounting for the tripod of a solar compass is therefore entirely impracticable, and hence when short sights have to be taken, which is unavoidable in a timbered or hilly country, much time is occupied in leveling the instrument. To these sources of delay and error must be added the time required for the frequent adjustment of the Latitude and Declination arcs of the instrument, and the error resulting from the unequal refraction of the sun's rays by the atmosphere at different times and places.

Notwithstanding, however, all these objections and sources of error, the solar compass can be used with much advantage and considerable accuracy, by a skilful surveyor, in an open country and where long sights can be taken.

It is not my purpose in this paper to discuss the office work of the surveyor, which includes "supplying omissions" in the survey; this, however, has been ably treated in these pages by Professors Philbrick and Abbe. (See ANALYST, Vol. II, pp. 116 and 182.) But as it is desirable that the field work of the surveyor should not be interrupted by trigonometrical calculations, I add the following description of an easy method of continuing the measurment of a line across a stream or pond that cannot be chained, without any calculation:

Let P represent the stream or pond and BA, a portion of the line. With the instrument at the station S, set a flag at A, on the opposite side of the stream or pond, and also set a flag at D, any convenient point on the line, in the opposite direction from S. Take any point C, at right-angles with the line AB from the station S and at any convenient distance, which need not be measured. Set the instrument at the station C and direct the sights to the flag at A and note the angle SCA; turn the instrument towards a flag to be placed at a point B, which must be kept in range with the flag at D by an assistant at S, making the angle SCB equal the angle SCA.



Now because of the similar triangles SCA and SCB having a common side CS, we have $SB = SA$; therefore chain back from S to B, and the result will be the length of the line produced to A.

When a back sight to B is not practicable the equivalent of the line SA may be chained by constructing on SA an equilateral triangle one side of which shall lie wholely on the opposite side of the stream.

QUERY. BY THE EDITOR. If a cube be cut by four vertical planes each of which intersects two contiguous vertical faces along their center lines, thus cutting away half the volume of the cube; and if the two ends of the remaining parallelopipedon be each cut by four planes, each of the four planes passing through the center of the upper and the lower base, respectively, making an angle of 45° with the vertical axis and intersecting two contiguous sides of the parallelopipedon at equal angles, thus cutting off the *eight corners* of the parallelopipedon, the remaining solid is a crystaline form known to mineralogists as a "rhombic dodecahedron," (Dana,) having twelve faces and fourteen solid angles. Through the center of this solid let a plane be passed which shall intersect its six parallel edges at right-angles, and the solid will be divided into two equal and similar solids which are identical in form with the honey bee's cell; that is, each will be a hexagon terminated by three planes which make respectively an angle of $54^\circ 44' 8''$ with the axis of the hexagon. Though this is the angle which gives a minimum surface for a given volume, and therefore would seem to indicate intelligence and design in its construction, yet being a crystaline form, may not the physical forces which determine the position of the molecules in the formation of the rhombic dodecahedron influence the action of the bee in the construction of its cell rather than the intelligence and design of the bee?